

DRAWINGS ATTACHED

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(4) 1024

(54) FILTER ELEMENTS

(71) We, FRAM EUROPE LIMITED, formerly known as FRAM FILTERS LIMITED, of Llantrisant, Pontyclun Glamorgan, A British Company, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

5 The present invention relates to the production of filter elements.

Filter elements in which a filter medium is provided with at least one end cap formed of plastics material have been known for a number of years, and it is an object of the present invention to provide a filter element of this type which is simple to manufacture and which is more convenient to use than filter elements previously proposed.

15 In accordance with this object, the present invention provides in one aspect thereof, a filter element having a filter medium secured to at least one end cap formed of a first plastics material and having an integrally moulded gasket formed of a second plastics material of lesser hardness than the first and covering substantially the entire free end face of the end cap.

20 In a second aspect of the present invention, we provide a filter element comprising an annulus of pleated sheet filter material having an annular end cap formed of plastics material secured to at least one axial end thereof; the annular end cap including an integrally moulded annular gasket over substantially its free face formed of a plastics material of lesser hardness and greater flexibility than the material of the remainder of the end cap and providing a flat sealing surface at the axial end of the filter element of substantial extent both in the circumferential and radial directions.

45 In a third aspect of the present invention,

there is provided a method of making a filter element having a filter medium secured to at least one end cap having an integral gasket covering substantially entirely its free end face, the method comprising the steps of dispensing into a mould a predetermined quantity in liquid or paste form of a first plastics material chosen to have an ultimate hardness when set or cured applicable for use as a flexible gasket; allowing the material to set or cure in the mould; subsequently dispensing a predetermined quantity of a second plastics material also in liquid or paste form into the mould without substantial interpenetration at the interface formed between the two materials, the second material being chosen to be compatible with the first mentioned material and to have an ultimate hardness when set or cured greater than that of the first material and applicable for use as a filter element end cap; and sinking an end portion of a filter medium into the second material in the mould at least before the second material is completely cured or set so that when the curing or setting of the second material is complete the resulting end cap with its integral gasket may be removed from the mould secured to the end portion of the filter medium; the shape of the mould being so chosen in relation to the predetermined quantities of the first and second plastics materials that in the resultant filter element the integral gasket formed of the first plastics material covers substantially entirely the free end face of the end cap proper formed of the second plastics material.

This invention also provides, in a fourth aspect thereof, a method of making a filter element having an annulus of pleated sheet filter medium secured to at least one annular end cap having an integral annular gasket covering substantially entirely its free end face, the method comprising the

steps of dispensing into a mould having surfaces defining an annular cavity a predetermined quantity in liquid or paste form of a plastics material chosen to have an ultimate hardness when set or cured applicable for use as a flexible gasket; allowing the material to set or cure in the mould; subsequently dispensing a predetermined quantity of a second plastics material also in liquid or paste form into the mould without substantial interpenetration at the interface formed between the two materials; the second material being chosen to be compatible with the first mentioned material and to have an ultimate hardness when set or cured greater than that of the first material and applicable for use as a filter element end cap; and sinking an axial end portion of an annulus of pleated sheet filter medium into the second material in the mould at least before the second material is completely cured or set so that when the curing or setting of the second material is complete the resulting annular end cap with its integral annular gasket may be removed from the mould secured to the axial end portion of the filter medium annulus.

The two plastics materials are so chosen as to be compatible one with another. Not only must the two materials be compatible in the sense that in the completed article they must not separate one from another, but they must also be compatible in the sense that the setting or curing of the second plastics material must not be such to deleteriously effect the first material. In preferred examples the materials are either both cold cured or both hot set. The materials may both be quite different as for example the soft material may be polyvinylchloride and the harder material may be a polyurethane. Alternatively, the two plastics materials may consist of the same polymer one of which is arranged to be cured or set in a denser form than the other. This may be readily achieved for polyurethanes which have a two-part mix and a cold cure.

The invention is hereinafter more particularly described by way of example only with reference to the accompanying drawings in which:—

FIGURES 1 to 3 show successive stages in the manufacture of a filter element in accordance with the present invention.

Mould 1 has (as shown in the axial sectional view of Figure 1) a flat bottom surface 2 and concentric upstanding side surfaces 3, which together define an annular cavity. The first step in putting into practice a specific method of moulding in accordance with the present invention is the cleaning of the cavity defining surfaces and the spraying of a suitable mould release agent such as the silicone oil type widely sold.

There is then dispensed into mould 1 a predetermined quantity of a first plastics material in liquid or paste form. The plastics material 4 is chosen from a class of materials having an ultimate hardness when set cured appropriate for use as a flexible gasket, and the quantity of material is chosen so that it fills the lower part of the mould to a height sufficient to form a seal. The exact height can be regulated to achieve a total height for the finished filter element as required. The material 4 is then allowed to set, or alternatively is cured (depending on the nature of the polymer employed). Subsequently, following the complete setting or curing of the material 4, a predetermined quantity of a second plastics material 5 also in liquid or paste form is dispensed into the mould on top of the gasket plastics material 4 without substantial interpenetration at the interface formed between the two materials (Figure 2), and preferably until the second material fills the mould cavity. This second plastics material 5 is chosen from that class of material which is compatible with the plastics gasket material 4 in the sense outlined above and also has an ultimate hardness when set or cured different from that of the gasket plastics material 4 and suitable for use as a filter element end cap proper. An annulus 6 of pleated sheet filter material (preferably paper) is sunk into the second plastics material before it is cured or set, or before it is completely cured or set. The filter material annulus may be pushed into the denser material 5 until it rests on the surface of the first material now set or cured in the bottom of the mould.

Provided the two plastics materials have been correctly chosen, the result upon the completion of the cure or set of the second material is the production of a unitary filter element in which the individual pleats are sealed at their ends in the end cap material and an integral annular gasket is provided on the axial end of the end cap material. When a suitable end cap is provided on the other axial end of filter material annulus 6, the resulting product is immediately suitable as a replaceable filter element. The second end gap may be provided in a manner similar to that described hereinabove for the provision of the first. The integrally moulded gasket produced by the method described covers substantially the entire free end surface of the end cap and has a flat flexible sealing surface of substantial extent both in the radial and circumferential directions. We have found that such an integral gasket can provide a satisfactory seal even when the surface against which it is pressed to perform a sealing function is irregular. By integrally moulding the gasket as part of the end cap all problems of a proper

fit or sealing of the gasket are avoided.

We have found that polyurethane is particularly suitable for both plastics materials since it has a two-part mix and a cold cure and there are obviously no compatibility problems. In putting the method shown in Figures 1 to 3 into practice using polyurethane, after cleaning the mould and spraying with a mould release agent, we first dispense the more flexible polyurethane into the mould to the level shown in Figure 1, the material being chosen so that it has an ultimate Shore hardness of between 40°A and 90°A. The polyurethane layer in the bottom of the mould is then cold cured. The second polyurethane is subsequently dispensed on top of the cured flexible layer without any substantial inter-mingling or inter-penetration between the two layers. This second material is chosen so that its ultimate hardness when completely set or cured is in the range 50°D to 100°D Shore. The pleated sheet filter material is then positioned in the upper layer of polymer, and allowed to sink until it just rests on the uppermost part of the cured layer in the bottom of the mould. The cold cure of the second material is completed, and the whole article released from the mould. We prefer to use the same procedure at the other axial end of the filter element.

Methods in accordance with the present invention are not restricted to the use of the same plastics material in two mixes of different ultimate hardness; different materials can be used. For example, we have carried out a method in accordance with the present invention to provide a filter element which moulded plastics end caps having integrally moulded gaskets in which the material of the end cap was a polyurethane and the material of the gasket polyvinylchloride. Those skilled will readily appreciate which of the well known plastics materials are compatible in the sense defined above (and thus useful for putting this invention into practice) without further instruction.

We have specifically described above methods of putting this invention into practice in the production of pleated sheet filter elements of annular configuration. Whilst this invention is particularly applicable in the manufacture of such filter elements which are widely employed as replaceable filter cartridges for the filtration of air for internal combustion engines, it will be readily appreciated that this invention is not restricted to such filters alone. This invention can be employed equally well and with results just as satisfactory in the provision of moulded end caps or supports on filter elements of other configurations which may employ filter media of other kinds, whether of the surface or

depth types. All such filter elements require an adequate seal with an adjacent surface to operate satisfactorily; and gaskets integrally moulded with the end caps of such elements in the manner proposed by us can perform this function without any problems of a proper seating between the end cap and a separate gasket.

It is sometimes required that additional support be given to the filter medium. For example, with annular pleated paper filter elements, an internal support in the form of a perforated metal cylinder is often employed. It will be readily appreciated that all such associated "hardware" can be incorporated during the provision of the end caps with their integral gaskets as described above. The resulting end caps will encapsulate the ends of such additional support members or other hardware as well as the end portion of the filter medium itself.

#### WHAT WE CLAIM IS:—

1. A filter element having a filter medium secured to at least one end cap formed of a first plastics material and having an integrally moulded gasket formed of a second plastics material of lesser hardness than the first and covering substantially the entire free end face of the end cap.
2. A filter element comprising an annulus of pleated sheet filter material having an annular end cap formed of plastics material secured to at least one axial end thereof; the annular end cap including an integrally moulded annular gasket over substantially its entire free face formed of a plastics material of lesser hardness and greater flexibility than the material of the remainder of the end cap and providing a flat sealing surface at the axial end of the filter element of substantial extent both in the circumferential and radial directions.
3. A filter element according to Claim 1 or Claim 2, wherein the materials of the gasket and end cap proper are chosen from plastics of different chemical types but which are compatible one with the other to secure a bond therebetween.
4. A filter element according to Claim 3, wherein the gasket is formed of polyvinylchloride and the end cap proper is formed of polyurethane.
5. A filter element according to Claim 1 or Claim 2, wherein the gasket and the end cap proper are formed from the same type of polymer, the exact compositions being chosen so that the material of the former has a lesser hardness than the material of the latter.
6. A filter element according to Claim 5, wherein the gasket and the end cap proper are both formed of polyurethane.
7. A filter element according to Claim



6, wherein the material of the gasket has a Shore hardness of between 40°A and 90°A, and the material of the end cap proper has a Shore hardness of between 50°D and 100°D.

8. A filter element according to any preceding Claim, provided with an exactly similar end cap, with an integrally moulded gasket, at the end thereof opposite the first end cap.

9. A method of making a filter element having a filter medium secured to at least one end cap having an integral gasket covering substantially entirely its free end face, the method comprising the steps of dispensing into a mould a predetermined quantity in liquid or paste form of a first plastics material chosen to have an ultimate hardness when set or cured applicable for use as a flexible gasket; allowing the material to set or cure in the mould; subsequently dispensing a predetermined quantity of a second plastics material also in liquid or paste form into the mould without substantial interpenetration at the interface formed between the two materials, the second material being chosen to be compatible with the first mentioned material and to have an ultimate hardness when set or cured greater than that of the first material and applicable for use as a filter element end cap; and sinking an end portion of a filter medium into the second material in the mould at least before the second material is completely cured or set so that when the curing or setting of the second material is complete the resulting end cap with its integral gasket may be removed from the mould secured to the end portion of the filter medium; the shape of the mould being so chosen in relation to the predetermined quantities of the first and second plastics materials that in the resultant filter element the integral gasket formed of the first plastics material covers substantially entirely the free end face of the end cap proper formed of the second plastics material.

10. A method of making a filter element having an annulus of pleated sheet filter medium secured to at least one annular end cap having an integral annular gasket covering substantially entirely its

free end face, the method comprising the steps of dispensing into a mould having surfaces defining an annular cavity a predetermined quantity in liquid or paste form of a plastics material chosen to have an ultimate hardness when set or cured applicable for use as a flexible gasket; allowing the material to set or cure in the mould; subsequently dispensing a predetermined quantity of a second plastics material also in liquid or paste form into the mould without substantial interpenetration at the interface formed between the two materials; the second material being chosen to be compatible with the first mentioned material and to have an ultimate hardness when set or cured greater than that of the first material and applicable for use as a filter element end cap; and sinking an axial end portion of an annulus of pleated sheet filter medium into the second material in the mould at least before the second material is completely cured or set so that when the curing or setting of the second material is complete the resulting annular end cap with its integral annular gasket may be removed from the mould secured to the axial end portion of the filter medium annulus.

11. A method according to Claim 9 or 10, wherein the filter medium is sunk into the second material in the mould until it rests on the surface of the first mentioned material set or cured in the bottom of the mould.

12. A method according to one of Claims 9, 10 or 11, wherein the first and second plastics materials comprise the same polymer in mixes having different ultimate hardness.

13. A method of making a filter element substantially as hereinbefore described with reference to the accompanying drawings.

14. A filter element substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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FIG.1

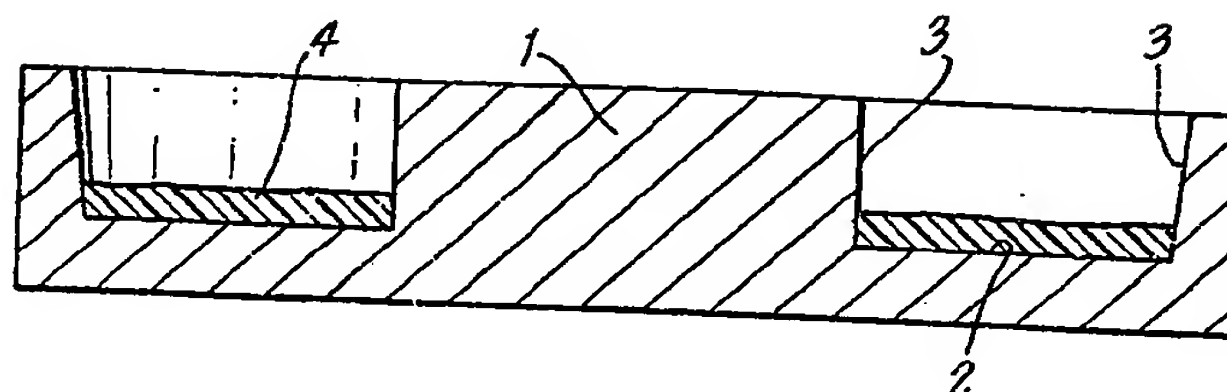


FIG.2

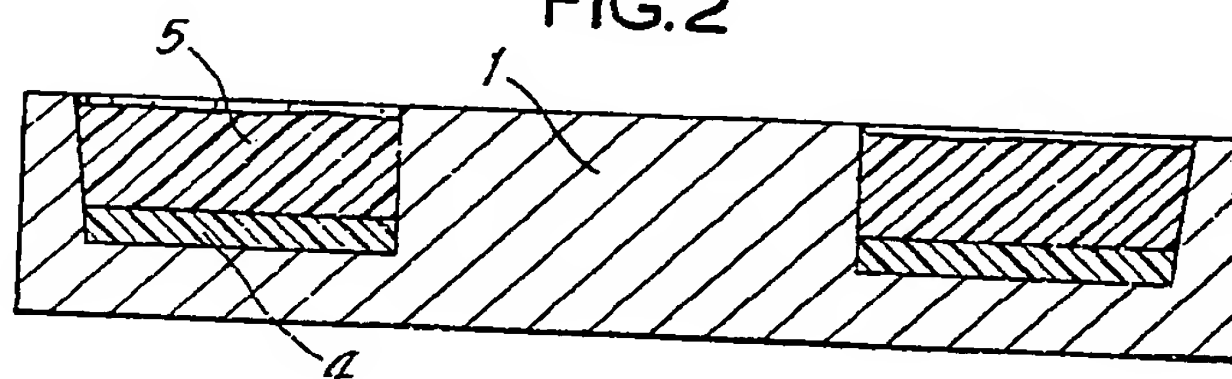


FIG.3

